Addendum 01

Smoky Canyon Mine
Remedial Investigation/Feasibility Study
Sampling and Analysis Plan

May 2011 (Addendum 01) to
June 2010 (Final) SAP

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REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QAPP Addendum 01, May 2011

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(SAP ADDENDUM 01, MAY 2011)

Groundwater Data Gaps	Investigation Activity Description	Sampling or Measurement Locations	Planned Sampling Frequency/Duration
Additional evaluation of Wells Formation groundwater flow directions and hydraulic gradients	Monitoring Well Installation	GW-CO-2	Install new well
	Wells Formation Water Level Monitoring	GW-27	Continuous monitoring using transducer at new well GW-27 (see next page for water level monitoring planned for GW-CO-2)
Analyses of groundwater samples for the complete list of RI COPCs	Wells Formation Groundwater Quality Monitoring	New monitoring well GW-27	Two times (see next page for sampling planned for GW-CO-2)

TABLE 1-1. REMEDIAL INVESTIGATION FIELD AND DATA COLLECTION ACTIVITIES FOR 2011
(SAP ADDENDUM 01, MAY 2011)

Groundwater Data Gaps	Investigation Activity Description	Sampling or Measurement Locations	Planned Sampling Frequency/Duration
Analyses of groundwater during and immediately after installation of the new Consent Order monitoring well (GW-CO-2)	Wells Formation Groundwater Quality Monitoring	New monitoring well (GW-CO-2)	When uppermost Wells Formation water is encountered, collect water sample (if possible) and analyze for RI COPCs (dissolved), including major cations/anions. After well development, collect an unfiltered sample and analyze for RI COPCs, including major cations/anions.
			Opportunistic sampling at multiple depths, as practical, when borehole is advanced through separate water-producing zones (if any); analyze any samples for dissolved selenium and sulfate.
			Water quality sampling on 2 occasions – once in the Spring and once in the Fall - at least one month after well development; analyze for RI COPCs, including major cations/anions (see Table 3-2 of FSP/SAP).
		New monitoring well (GW-CO-2) and Industrial Well	Approximately monthly water quality sampling for 3-6 months; analyze samples for total and dissolved selenium and sulfate as well as other parameters specified by Formation (2011b) on Table 7 of the *Draft Corrective Action Completion Report for the Culinary Well and Corrective Action Plan for the Industrial Well* (February 28, 2011).
	Wells Formation Water Level Monitoring	New monitoring well (GW-CO-2)	Daily measurement, as drilling and borehole conditions allow, prior to developing the well. Continuous transducer after well developed.

TABLE 1-1. REMEDIAL INVESTIGATION FIELD AND DATA COLLECTION ACTIVITIES FOR 2011
(SAP ADDENDUM 01, MAY 2011)

Surface Water Data Gaps	Investigation Activity Description	Sampling or Measurement Locations	Planned Sampling Frequency/Duration
Seasonal high-flow and low-flow sampling of surface water with analyses for the complete RI COPC list	Surface Water Monitoring	Sage Creek (LSV-4) and Crow Creek (CC-350, CC-1A, and CC-WY-01)	Two times in 2011 (high-flow and low-flow conditions)
Seasonal high-flow and low-flow stream-flow/discharge measurements	Surface Water Flow Monitoring	Sage Creek (LSV-4) and Crow Creek (CC-350, CC-1A, and CC-WY-01)	Two times in 2011 (high-flow and low-flow conditions) coinciding with sampling
Seep sampling with analyses for the complete RI COPC list	Seep Water Monitoring	Seeps DS-7, ES-3, LP-1	Three times (spring, summer, fall) during seep flow monitoring (see below)
Continuous seep-flow monitoring at DS-7 and ES-3	Seep Flow Monitoring	Seeps DS-7, ES-3	6-9 months, including the snowmelt runoff season

2.0 QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN
TABLE 2-7

Table 2-7 (QAPP Addendum 01, May 2011)

Requirements for Sample Preservation and Preparation Techniques, Sample Volumes, and Holding Times

Parameter	Referenced Method	Sample Preparation Method	Preservative[1]	Minimum Sample Volume	Maximum Holding Time (Days)
Solid Matrices (Sediment, Soil, Vegetation, Biological Tissue)					
Metals and metalloids (COPCs)	EPA 6010B and EPA 6020 (ICP and ICP-MS)	Total Digestion-hot plate (M3050B) for sediment, soil and vegetation; closed vessel digestion for non-vegetation tissues	None	5 g	180
Mercury	EPA 7471A	Preparation per method 7471A	None	5 g	28
Selenium	EPA 7742 Modified or SM 3114C, AA-Hydride	Total Digestion-methods 3050B and SM 3114B for sediment and soil; method 3050B for vegetation; closed vessel digestion for non-vegetation tissues	None	5 g	180
pH	USDA No. 60 [21A]	Saturated Paste (USDA No. 60[2])	None	20 g	ASAP
Percent Solids for Soil, Sediment, and Fish	CLPSOW390, Part F, D-98, Freeze-Dry (CAS SOP/NOAA Status & Trends)	None	None	10 g	NA
Total Organic Carbon	ASTM D4129 (modified)	None	None	20 g	28
Fish (and other aquatic tissue) Sample Preparation	EPA 600/4-81-055	Fish Tissue Pulverization	None	Entire sample	NA
Moisture Content for Plant Tissue	M209F, Gravimetric-60C	None	None	Entire sample	NA
Plant-Tissue Sample Preparation	Homogenization (CAS SOP)	Plant Tissue Pulverization	None	Entire sample	NA
Sediment Sample Preparation	USDA No.1 ASA No.9 15-4.2.2; ASTM D422	Air Dry at 34°C and Sieve-2.0mm	None	Entire sample	NA
Water Matrices (Surface Water, Groundwater)					
Metals and metalloids (COPCs), Hardness	EPA 6010B and 6020 (ICP and ICP-MS)	Field filtered (dissolved), Hot Plate Digestion 3005A (6010B) or 3020A (6020)	HNO_3	500 mL	180
		Unfiltered (total); Hot Plate Digestion 3005A (6010B) or 3020A (6020)	HNO_3	500 mL	180
Chromium VI (surface water only)[3]	EPA 7199[3]	Field filtered (dissolved); extract per method 7199	None	50 mL	1 (24 hours)[3]
Mercury	EPA 7470A	Field filtered (dissolved), preparation per method 7470A	HNO3	50 mL	28
		Unfiltered (total); preparation per method 7470A	HNO3	50 mL	28
Major cations (Ca, Mg, K, Na)	EPA 6010B	Field filtered (dissolved), Hot Plate Digestion 3005A	HNO_3	250 mL	180
Chloride, Sulfate	EPA 300.0 (Ion Chromatography)	None	None	50 mL	28
Nitrate+nitrite, as N	EPA 353.2	None	H_2SO_4	50 mL	28
Alkalinity (Alkalinity, Bicarbonate Carbonate, Hydroxide), TDS, TSS	SM2320B (Titration), SM 2540C (TDS), SM 2540D (TSS)	None	None	100 mL	14 (Alkalinity) 7 (TDS, TSS)
Total Organic Carbon	SM 5310B	None	H_2SO_4	50 mL	28
Selenium[2]	SM3114C (AA-Hydride)[2]	Field filtered (dissolved), Digestion per method SM3114B	HNO_3	25 mL	180
		Unfiltered (total); Digestion per method SM3114B	HNO_3	25 mL	180

[1]In addition to the preservation listed, all samples shall be maintained at 4 ° ± 2°C or frozen (biological tissues) following collection and during shipment to the lab.

[2]Specific parameters are media or sample type specific, see appropriate table in Field Sampling Plan.

[3]Chromium speciation will only be run if a previous result for total chromium was ≥0.011 mg/L.

3.0 FIELD SAMPLING PLAN

The scope of Smoky Canyon Mine RI field data collection was determined during preparation of the RI/FS Work Plan (Formation, 2011c). That document identifies the specific objectives of the RI, identifies remaining data gaps, and describes the corresponding rationale for and design of investigations to address those data gaps. The media that require further characterization for the purposes of the RI are:

- groundwater (Wells Formation, alluvial system, and local domestic water supply wells or springs);
- surface water (streams, seeps, and stormwater detention basins);
- sediment (streams and stormwater detention basins);
- soil/overburden;
- terrestrial biota (vegetation, invertebrates, and small mammals); and
- aquatic biota (fish tissue and macroinvertebrates).

Additional data are needed to better characterize the nature and extent of COPCs, fate and transport of COPCs, and any related baseline risks to human and ecological receptors. The primary data gap for all environmental media is to assess the nature and extent of the additional COPCs identified for the RI/FS beyond those that were evaluated in previous studies, including the SI.

This section of the SAP provides detailed descriptions of the field investigation activities for the RI, including sampling plans for each investigation task and specific procedures that will be used during field programs and other data collection activities. Also, sample collection locations and the planned frequency/schedule for monitoring are specified. For the RI/FS, sampling seasons are generally defined as winter (January through March), spring (April through June), summer (July through September), and fall (October through December). The field investigations that will be performed during the RI include installation of one or more groundwater monitoring wells and sampling and other data collection activities to characterize groundwater, surface water, sediment, soil, terrestrial vegetation and other terrestrial and aquatic biota.

As part of data collection, coordinates for new monitoring locations will be recorded from global positioning system (GPS) unit readings. Coordinates for existing monitoring locations were recorded during past sampling events and are currently available for use.

3.1 Site Access

The majority of the Smoky Canyon Mine is bordered to the east by Sage Valley, where most of the land is privately owned (Figure 3-1). Although a significant portion of the field investigations described herein will be conducted on federal lands, some field investigations are also planned on private lands in Sage Valley. Simplot has existing access agreements with these private land owners and will review the access agreements to ensure that they are of sufficient scope and duration to permit the field activities described in this SAP. Any insufficient access agreements will be renegotiated with the land owner. These agreements allow access by Simplot and their contractors, as well as representatives from the Agencies. Routine access will be needed throughout the RI for well installation and maintenance, groundwater monitoring, surface water monitoring, and the other field activities outlined by this plan.

3.2 Groundwater Investigations

The groundwater investigations identified by the RI/FS Work Plan (Formation, 2011c) include:

- Wells Formation Monitoring Well Installation;
- Water Level Monitoring;
- Water Quality Monitoring for COPCs;
- Groundwater Monitoring During Installation and Initial Operation of the New Consent Order Monitoring Well;
- Wells Formation Groundwater Sampling Using High-Flow Methods;
- Detailed Groundwater Discharge Sampling at Hoopes Spring Complex;
- Sage Creek/Wells Formation Stream Loss Survey;
- Discrete-Depth Sampling at Well GW-22;
- Sage Creek/Alluvial Flow System Gain-Loss Survey; and
- Inventory and Sampling of Alluvial Discharges to Surface Water in Sage Valley.

These investigations are summarized on Table 1-1.

3.2.1 Objectives

The objectives of the RI groundwater investigations are to ensure that sufficient data are available to adequately assess the nature, extent, fate, and transport of RI COPCs in the Wells Formation aquifer and the alluvial groundwater flow system at the Smoky Canyon Mine. The data will be used for Site characterization and risk assessment. The specific data collection objectives for the Wells Formation aquifer and the alluvial groundwater flow system are discussed in Sections 3.2.2 and 3.2.3, respectively.

3.2.2 Wells Formation Aquifer

As detailed in the RI/FS Work Plan (Formation, 2011c), data are available for all of the existing Wells Formation monitoring wells for all RI COPCs. These data are available to be used for characterization of nature, extent, fate, and transport of COPCs. Additional analyses of RI COPCs will be performed for groundwater from new Wells Formation wells installed before or during the RI and for existing wells to provide the additional data needed to support the risk assessment. New wells that are currently planned include 1) a new monitoring well (GW-CO-2) that Simplot plans to install in 2011 along Smoky Creek, northeast of the Industrial Well, and 2) a new Wells Formation monitoring well (GW-27) that will be installed as part of the RI at a location between the Pole Canyon ODA and Panel E. Although the new monitoring well (GW-CO-2) is being installed under the Panels B and C IDEQ Consent Order process, Simplot will ensure that samples are collected from the new well to provide usable data for evaluation of Wells Formation groundwater in the northern portion of the Site. Specific data collection activities at the new well, along with analyses, are described in Section 3.2.2.2 and summarized in Table 1-1. The location of the new Wells Formation monitoring well (GW-27), between Panels D and E, will be established in consultation with the Agencies. The well installation methods that will be used to construct the new Wells Formation monitoring well (GW-27) are detailed in Section 3.2.2.1 below.

Investigation of the Wells Formation aquifer and groundwater quality will include a variety of activities, as follows:

- Analyses of groundwater samples from the new monitoring well (GW-CO-2), the new monitoring well (GW-27), and existing Wells Formation monitoring wells;
- Measurement of groundwater levels in all Wells Formation monitoring wells, including the three new wells recently installed in Panel F, the new well (GW-CO-2), and the new well (GW-27) to be installed between Panels D and E;
- Additional evaluation of Wells Formation groundwater flow directions and hydraulic gradients in the vicinity of Pole Canyon and Panel D (the aforementioned new monitoring well [GW-27] will provide information to support this evaluation);
- Collection of groundwater samples from three apparently “clean” existing wells GW-18, GW-24, and GW-25 using high pumping rates with analyses of the resulting samples for selenium and other overburden indicator parameters;
- Detailed flow measurements in Sage Creek, upstream of Sage Valley, to assess stream loss to the Wells Formation aquifer (refer to Section 3.3);
- Collection and analyses of Wells Formation groundwater samples at locations of discharge to Hoopes Spring and South Fork Sage Creek springs for the complete list of RI COPCs (refer to Section 3.3); and
- Collection of discrete groundwater/spring water samples at various locations within the Hoopes Spring Complex area with analysis of these samples for selenium and other overburden indicator parameters, along with major ions (refer to Section 3.3).

The sampling methods that will be used for the first four items of the Wells Formation groundwater investigation tasks, listed above, are described in this section. The methods used to collect the flow measurements and water samples specified in the last three items are described along with methods for conducting similar field tasks identified for surface water investigations in Section 3.3 below.

3.2.2.1 Wells Formation Monitoring Well Installation

One new Wells Formation monitoring well will be installed as part of the RI. Drilling and well construction methodologies for this new deep monitoring well are described in this section. More detailed SOPs for well installation, completion, and development are referenced below and included in the FSP Attachment.

In addition, a new monitoring well (Consent Order Well 2 [GW-CO-2]) will be installed in Spring 2011 to serve as an indicator well under the Panels B and C Consent Order (Formation, 2011a). This new monitoring well will be located northeast of the Industrial Well (Figure 3-3) and will also provide data for use in the RI.

<u>Location</u>

The new monitoring well (GW-27) will be installed in the area between the Pole Canyon ODA and Panel E at a specific location to be determined through consultation with the Agencies. Figure 3-3 shows the location proposed for this new well. The proposed location is adjacent to the Panel D external ODA, west of the Boulder Creek Anticline axis. The well location will be on public land administered by the U.S. Forest Service. The new well will be designated GW-27.

The well will be designed to screen the uppermost saturated zone in the Wells Formation aquifer, consistent with the other monitoring wells currently in use at the Site.

<u>Drilling and Logging</u>

A drilling contractor with experience drilling in the geologic conditions present at the Site will be used. The driller will be selected based on cost, technical expertise and knowledge of the local geology. The bedrock boring for the deep well will be drilled using percussion-hammer, rotary (air, wet or mud) or a combination of drilling methods. The method ultimately used will be selected based on the driller's experience with the rock type and conditions present in the area. For example, the unconsolidated deposits may be drilled more efficiently with rotary methods, while the percussion hammer may be most efficient for the bedrock strata. Most percussion-hammer drilling rigs are capable of both percussion and rotary methods. Initially, the drilling will use air or water as the circulating media to return cuttings to the surface. In some conditions, other fluids or additives may be needed. A discussion of the use and management of such fluids and additives is included in NewFields SOP No. 23, Installation of Deep Bedrock Monitoring Wells and Piezometers (FSP Attachment).

The deep boring will be advanced at least 50 feet into the saturated portion of the Wells Formation. The expected total depth of the boring is unknown because the boring location has not been selected. However, it is possible that the total depth of the boring could range from 400 feet to 1,000 feet or more.

Drill cuttings from the deep bedrock borehole will be collected and logged on 5- to 10-foot intervals for lithologic and stratigraphic evaluation. Drilling and logging procedures will be performed in accordance with MFG SOP No. 4JRS, Supervision of Exploratory Borings (FSP Attachment). Chemical analysis of the bedrock cuttings will not be required. Samples of any materials placed in the borehole during well drilling to assist in maintaining circulation or borehole stability will be collected and archived at the Site. The samples can be analyzed to help resolve any questions should the groundwater sample results raise issues that could be attributed to these materials.

<u>Deep Monitoring Well Installation</u>

The following goals need to be considered in the selection of an appropriate well design that will meet the monitoring objectives:

1. Provide detection of changes in groundwater quality in the uppermost portion of the aquifer.

2. Accommodate seasonal and yearly fluctuation in groundwater-level changes.

3. Isolate shallow water-bearing units encountered above the major aquifer in the Wells Formation.

4. Accommodate a variety of submersible groundwater pumps.

5. Allow flexibility in depth of sample collection.

6. Provide durability and reliability for long-term use to support groundwater monitoring programs.

The following well-screen design addresses the monitoring objectives listed above:

<u>Well Screen Length</u> – The well screen will be installed within the saturated portion of the aquifer. If the aquifer is locally unconfined, the screen will be extended above the water level. If the aquifer is locally confined the screen will be restricted to the water-bearing zone. The specific length of the well screen will be based on the conditions observed during drilling.

<u>Diameter</u> – The well screen diameter will be 4 inches. This allows for a variety of pumps to be used for well development, well testing, and groundwater sampling.

<u>Well Screen</u> – Continuous-slot, stainless steel, with an opening of 0.020 inches, will be used for well screen. This slot size provides a large open area for flow through the

screen and maximizes the efficiency of the connection between the well and the formation.

Well Casing – All blank well casing installed above the screen interval will consist of low-carbon steel.

Filter Pack – 10-20 silica sand will be placed between the screen and formation to provide annular stability and filtration. This size of filter pack may not provide optimum filtration of some of the fine-grained sand present in the Wells Formation at high entrance velocities, but this should not cause problems at the lower velocities typically encountered during sampling.

In summary, the well will be constructed from 4-inch-nominal-diameter, low-carbon steel casing, stainless-steel screen, and an end cap. Figure 3-2 is a schematic well construction and completion diagram.

The deep bedrock well will be constructed and installed in accordance with the Site-specific procedures presented in NewFields SOP No. 23, Installation of Deep Bedrock Monitoring Wells and Piezometers (FSP Attachment), which are briefly summarized here.

The casing and screen will be centered and hung in the borehole. Centralizers will be used as needed. The well string will be held under tension in order to prevent crushing of the screen and to keep the well plumb until grout placement has been completed. The filter pack described above will be installed to a level above the well screen that is appropriate based on the specific conditions observed during drilling. The height of the filter pack above the screen will ultimately be dependent on the presence or absence of water-producing zones above the screen. As was stated above as a performance goal, the well design and construction should "isolate shallow water-bearing units encountered above the major aquifer in the Wells Formation." A bentonite seal consisting of bentonite chips, bentonite pellets, or high solids bentonite grout will be used from the top of the sand filter to within 40 feet of the surface to provide an annular seal. The remainder of the annular space between the borehole and the well casing will be filled with a cement grout. All grout will be placed using a tremie pipe.

The well will be completed above the ground surface with a steel surface casing and locking lid to protect the well. The Forest Service will be provided with duplicate keys for all wells completed on Forest Service land. Weep holes will be drilled in the base of the steel surface casing just above the ground surface to allow water to drain from inside the outer casing and prevent ice build-up. A 4-foot-diameter, 1-foot-thick, gravel pad will be placed around the well. The well will be surrounded by three concrete or steel posts, each 3 feet high, to protect the well head from collisions or other disruptions (refer to NewFields SOP No. 23, FSP Attachment).

Once the well installation is complete, a dedicated pump system will be installed for use in development and future routine purging and sampling. Dedicated tubing affixed to the pump will facilitate sampling, which also will necessitate the use of a truck-mounted generator to power the dedicated pump.

Well Development

The primary purpose of the well will be the collection of water quality samples; the wells will not be used for water supply. As such, extensive development to remove turbidity associated with high pumping rates and significant well and aquifer stress will not be needed. Instead, the purpose of the development will be to remove water from the well potentially affected by drilling and to minimize the potential turbidity in the well associated with the normal sample collection pumping rates.

A minimum of 24 hours shall elapse after well construction and before well development. The development program will be implemented without the use of dispersing agents, acids, etc.

Development will consist primarily of a combination of air lifting and pumping. If groundwater yield from the well is sufficient, over pumping will be used to optimize development. Surging with a surge block and bailing may also be performed, if necessary and practical. The development method will ultimately be selected by the field personnel and will depend on specific conditions encountered during drilling or well installation. Temperature, pH, conductivity, and turbidity will be monitored during development. Development will continue until the groundwater removed from the well is reasonably clear and free of sediments and the well produces water with stable field parameter readings (i.e., temperature, pH, conductivity). NewFields SOP No. 7, Monitoring Well Development (FSP Attachment).

During development pumping, groundwater level and pumping rate will be monitored frequently. This information can be used to assess the bulk hydraulic properties on the saturated portion of the screen interval, assess the productivity of the well, and assist in the final selection of a sampling pump.

Temperature, pH and conductivity will be monitored and recorded during development. Development will continue until the groundwater removed from the well is reasonably clear and free of sediments and the well produces water with stable field parameter readings (i.e., temperature, pH, conductivity), as described in NewFields SOP No. 7 (FSP Attachment).

Surveying

The location and elevation of the new well will be surveyed using conventional land surveying methods. The horizontal locations of the well will be surveyed to the nearest 0.1 foot using the State Plane coordinate system. The well elevation will be surveyed to the nearest 0.1 foot at both the ground surface and at a marked location (measuring point reference elevation) on the inner well-casing riser.

3.2.2.2 Wells Formation Groundwater Quality and Water Level Monitoring

Monitoring wells will be used to obtain groundwater samples and water-level measurements at the locations indicated on Table 3-1 for the parameters listed in Table 3-2. Groundwater samples will be obtained from the new monitoring well GW-CO-2 and new monitoring well GW-27. Groundwater will also be sampled at discharge points within the Hoopes Spring complex and South Fork Sage Creek springs, as described below in Section 3.3.

Water level measurements will be made at all of the Wells Formation monitoring wells at the Smoky Canyon Mine. The well locations are listed in Table 3-1 and shown on Figure 3-3.

Monitoring Locations and Frequency

At existing Wells Formation monitoring well locations, groundwater will be sampled once to supplement existing data from these locations. At each of the two planned new well locations (GW-27 and GW-CO-2), groundwater sampling in support of the RI will be conducted at least twice. Monitoring at the new monitoring well (GW-CO-2) will actually be more frequent in support of ongoing investigations of groundwater quality in the vicinity of Panels B and C. These two sampling events will be conducted during spring runoff conditions and again in the fall.

Water Level Measurements

Water levels will be measured at the Wells Formation monitoring locations listed in Table 3-1 continuously through the use of transducers that have already been installed in the existing wells or will be installed in the new monitoring well (GW-27). Data loggers will record the water levels measured using down-hole pressure transducers, and data will be downloaded at each monitoring location at least quarterly.

Inspection and Purging

Before each sampling event, wells to be sampled will be inspected and purged to help ensure that representative samples are collected. The wellhead will be inspected to ensure that the lock, protective cover (hinges), and well cap are in good condition and working order. The PVC casing and well cap should be clean of any dust or moisture prior to opening the well. When water level data are collected, the depth to water and the total well depth will be measured prior to well purging and sampling.

A dedicated, pneumatic piston pump (or equivalent) and low-flow methods will be used for purging and sampling of the new deep well GW-27 installed in the Wells Formation, and new monitoring well GW-CO-2. Well purging will use procedures consistent with those described in JRS SOP No. 4, Groundwater Sampling and Water-Level Measurements at Monitoring Wells and Piezometers (FSP Attachment), as briefly summarized below.

When low-flow purging is used, the well will be purged at a low pumping rate to minimize agitation of water in the well and minimize drawdown. The goal is to limit drawdown in the well to less than 10 percent of the length of the saturated well screen. If the initial water level is above the top of the screen, then the goal is to limit drawdown due to purging so that the water level in the well does not drop below the top of the screened interval. Wells will be purged by pumping water at a rate less than 250 mL per minute. When conventional purging must be used, each well will be pumped or bailed at least until the volume of water removed is equal to three casing volumes (volume of standing water in the well based upon total depth of well, the depth to water, and the well casing diameter).

To ensure that water samples are representative of the water-yielding zone, periodic measurements of the temperature, pH, and conductivity will be made during purging. Turbidity, dissolved oxygen and redox potential will also be measured periodically and immediately prior to sample collection as described in the sample collection subsection below. The sample will be collected only when the temperature, pH and conductivity reach a relatively constant value during purging (±10 percent for temperature and specific conductance, and ±0.5 pH units) or after three well volumes have been removed. If the yield of the well is low such that it can be bailed or pumped dry, then the recharged groundwater in the well will be considered representative regardless of the number of casing volumes of groundwater removed, because all standing water in the well has been replaced by recharge from the water-yielding zone.

<u>Sample Collection</u>

Groundwater samples will be collected after purging is complete and using the same equipment as used for purging at each location. Groundwater samples will be submitted for analyses listed in Table 3-2. At the same time that samples are collected for laboratory analysis, pH, conductivity, turbidity, dissolved oxygen, redox potential, and temperature measurements will be made using field instruments capable of the precision specified for these parameters in the QAPP (Section 2). Field measurements of ferrous iron and total iron (for calculation of ferric iron) will also be performed and recorded at the time of sample collection. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

During drilling of the new Consent Order monitoring well (GW-CO-2), when the uppermost Wells Formation water is encountered a filtered sample will be collected, if possible, and analyzed for RI COPCs (Table 3-2), including major cations/anions. Also, opportunistic samples will be collected at multiple depths, as practical, as the borehole is advanced and analyzed for dissolved selenium and sulfate; the number of such samples will ultimately depend on the conditions encountered during drilling. Water level measurements will be taken daily, as conditions allow, during drilling prior to well development; continuous water-level measurements will be initiated for the RI/FS as soon as possible after well development. After well development, an unfiltered sample will be collected and analyzed for RI COPCs, including major cations/anions. Then, at least one month after well development, samples will be collected at the Consent Order monitoring well (GW-CO-2) on two occasions (once in the spring and again in the fall) and analyzed for the full list of RI COPCs (Table 3-2). In addition, the new Consent Order monitoring well and the Industrial Well will be sampled monthly for the first three to six months after the new well is installed, and the samples will be analyzed for total and dissolved selenium and sulfate as well as other parameters specified by Formation (2011b) on Table 7 of the *Draft Corrective Action Completion Report for the Culinary Well and Corrective Action Plan for the Industrial Well* (February 28, 2011) (Formation, 2011b). The same sample collection protocols will be followed for sampling at the new Consent Order monitoringwell, as for the other monitoring wells.

The details of the groundwater sampling procedure are included in JRS SOP No. 4, Groundwater Sampling and Water Level Measurements at Monitoring Wells and Piezometers (FSP Attachment). A general description of the sampling procedure follows.

Sample bottles will be prepared specifically for the required analyses by the analytical laboratory, and they will be filled with sample water directly from pump tubing (or by pouring from the bailer). The sample bottles and preservation techniques used will be as described in the QAPP. For the filtered samples, groundwater will be pumped through a 0.45 µm in-line, high-capacity filter. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

Field quality control procedures and quality control sample types associated with groundwater sampling activities are described in the QAPP (Section 2).

3.2.2.3 Wells Formation Groundwater Sampling Using High-Flow Methods

In addition to the groundwater characterization for RI COPCs described above in Section 3.2.2.2, wells GW-18, GW-24, and GW-25 will each be sampled one time using a high-flow pumping rate to extract groundwater from a greater volume of the Wells Formation aquifer than would be extracted using low-flow methods. The higher flow rates will be achieved using a submersible pump that is capable of producing at least 5 feet of drawdown in each well. Based on well development information, the required flow rates are expected to vary from 10 to 25 gpm. The flow rate will be selected by controlling the discharge in the first minutes of pumping until the desired drawdown is obtained.

Multiple samples will be collected from each well using the following methods. Each well will be pumped for a continuous 12-hour period. During this time, field parameters -- temperature, pH, and conductivity -- will be measured and recorded. Turbidity, dissolved oxygen, and redox potential will also be measured periodically and immediately prior to sample collection. During the high-flow sampling event, the water level in the well will either be recorded frequently or monitored continuously using a pressure transducer. Samples will be collected at regular intervals as each well is pumped to obtain a total of six samples at each well. The samples collected from GW-18, GW-24, and GW-25 using the high-flow collection method will be analyzed for parameters typically associated with overburden – dissolved cadmium, manganese, selenium, and sulfate. These parameters can serve as indicators of transport from ODAs, and the presence of these parameters above typical concentrations in Wells Formation groundwater (i.e., upgradient of ODAs) can serve as an indicator for groundwater transport pathways from an ODA.

Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment). All other sample handling and analysis procedures shall be consistent with those specified above for other groundwater samples and in the QAPP (Section 2).

3.2.3 Alluvial Aquifer System

The RI/FS Work Plan (Formation, 2011c) outlines the data gaps associated with the alluvial aquifer system at the Smoky Canyon Mine. The nature and extent of contamination in the alluvial aquifer system was well characterized during the SI for the seven COPCs that were the focus of that investigation. However, since the SI was completed, additional COPCs have been identified for the RI/FS and two new alluvial monitoring wells have been installed. Thus, additional sampling of the alluvial aquifer system is needed to assess the nature and extent of the complete list of RI COPCs. Further, though the available information suggest that the alluvial aquifer system in Sage Valley is not acting as a transport pathway for selenium or other COPCs, from the Pole Canyon ODA to surface water in lower Sage Valley, additional investigation to identify gaining reaches in the Sage Creek drainage is warranted.

The RI/FS Work Plan (Formation, 2011c) identified the following tasks associated with the alluvial groundwater flow system (Table 1-1):

- Alluvial Groundwater Monitoring for COPCs;
- Alluvial Water Level Monitoring;
- GW-22 Discrete-Depth Sampling;
- Sage Creek Gain-Loss Survey in Sage Valley; and
- Inventory and Sampling of Alluvial Discharges to Surface Water in Sage Valley.

The specific activities that will be implemented to complete the characterization of the alluvial aquifer system for the purposes of the RI/FS are as follows:

- Collection and analyses of groundwater from the alluvial monitoring wells (see Table 3-1 and Figure 3-3) for the full RI COPC list (Table 3-2);
- Collection of groundwater level monitoring data from the alluvial monitoring wells;

- Analyses of alluvial groundwater samples from distinct depths corresponding to screened intervals in well GW-22 for the full RI COPC list (Table 3-2);
- Additional Sage Creek flow data to identify reaches in Sage Valley that gain water from the alluvial groundwater flow system (refer to Section 3.3); and
- Survey, sampling, and analyses of any alluvial groundwater discharged to upper Sage Valley (north of Sage Creek) and lower Sage Valley (between Sage Creek and South Fork Sage Creek) (refer to Section 3.3).

The groundwater monitoring methods for implementing the first three tasks listed above are described in this section. Methods associated with conducting the remaining tasks are described along with other surface water monitoring efforts in Section 3.3.

3.2.3.1 Alluvial Groundwater Quality and Water Level Monitoring

Monitoring Locations and Frequency

Groundwater sampling in wells for which RI COPCs were not previously analyzed (GW-17, GW-19b, GW-20, GW-21, GW-26) will be conducted twice in one year as indicated on Table 3-1, and analyzed for the full list of RI COPCs (Table 3-2). These two sampling events will be conducted during spring runoff conditions and again in the fall. Also, alluvial monitoring wells previously sampled and analyzed for the RI COPCs will be sampled one time, as indicated on Table 3-1, and analyzed for the full list of RI COPCs (Table 3-2).

Water Level Measurements

Water levels will be measured at the locations noted in Table 3-1 on a quarterly basis for an annual cycle, or continuously where transducers are installed (GW-15, GW-22, and GW-26). At locations where samples are collected, water-level measurements will be collected during each sampling event. A water-level measurement will be obtained prior to purging the well and also immediately following sampling. The total depth of the well will also be measured and recorded before purging the well.

Water levels will be measured to the nearest 0.01 foot using an electronic water-level indicator. The measurement will be made to the measuring point reference mark placed on the top of the PVC well casing. This mark should be placed on the north side of the casing and its elevation surveyed to the nearest 0.1 foot. Prior to use for each measurement, the water level indicator will be decontaminated with an Alconox® solution followed by a distilled water rinse.

All water-level and well-depth measurements will be obtained in accordance with the detailed procedures given in JRS SOP No. 4, Groundwater Sampling and Water Level Measurements at Monitoring Wells and Piezometers (FSP Attachment).

Inspection and Purging

Before each sampling event, wells to be sampled will be inspected and purged to help ensure that representative samples are collected. The wellhead will be inspected to ensure that the lock, protective cover (hinges), and well cap are in good condition and working order. The PVC casing and well cap should be clean of any dust or moisture prior to opening the well. When water level data are collected, the depth to water and the total well depth will always be measured prior to well purging and sampling. Well purging will use procedures consistent with those given in JRS SOP No. 4, Groundwater Sampling and Water Level Measurements at Monitoring Wells and Piezometers (FSP Attachment), as briefly summarized below.

A peristaltic pump will be the preferred method used for extracting the groundwater from the shallow alluvial aquifer monitoring wells (purging and sampling). Use of a peristaltic pump allows for purging and sampling at a low flow rate and is less likely to generate suspended sediment during sample collection. If conditions do not permit use of a portable peristaltic pump, then disposable bailers may be used instead and the well(s) may be purged using the conventional purge method described below and in JRS SOP No. 4 (FSP Attachment). For the shallow monitoring wells, dedicated pump tubing will be used to avoid cross-contamination between wells.

When low-flow purging and sample collection is used, each well will be purged at a low pumping rate to minimize agitation of water in the well and minimize drawdown. The goal is to limit drawdown in the well to less than 10 percent of the length of the saturated well screen. If the initial water level is above the top of the screen, then the goal is to limit drawdown due to purging so that the water level in the well does not drop below the top of the screened interval. Wells will be purged by pumping water at a rate less than 250 mL per minute. When conventional purging must be used, then each well will be pumped or bailed at least until the volume of water removed is equal to three casing volumes (volume of standing water in the well based upon total depth of well, the depth to water, and the well casing diameter).

To ensure that the water samples are representative of the water-yielding zone, periodic measurements of the temperature, pH, and conductivity will be made during purging. Turbidity, dissolved oxygen, and redox potential will also be measured periodically and immediately prior to sample collection as described in the Sample Collection subsection below. The sample will be collected only when the temperature, pH and conductivity reach a relatively constant value during purging (±10 percent for temperature and specific conductance, and ±0.5 pH units) or after three well volumes have been removed. If the yield of the well is low such that it can be bailed or pumped dry, then the recharged groundwater in the well will be considered representative regardless of the number of casing volumes of groundwater removed, since all standing water in the well has been replaced by recharge from the water-yielding zone.

Sample Collection

Groundwater samples will be collected after purging is complete and using the same equipment as used for purging at each location. Groundwater samples will be submitted for analyses listed in Table 3-2. At the same time that samples are collected for laboratory analysis, pH, conductivity, turbidity, dissolved oxygen, redox potential and temperature measurements will be made using field instruments capable of the precision specified for these parameters in the QAPP (Section 3). Field measurements of ferrous iron and total iron (for calculation of ferric iron) will also be performed and recorded at the time of sample collection. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

The details of the groundwater sampling procedure are included in a JRS SOP No. 4, Groundwater Sampling and Water Level Measurements at Monitoring Wells and Piezometers, which is included in the FSP Attachment. A general description of the sampling procedure follows.

Sample bottles will be prepared specifically for the required analyses by the analytical laboratory, and they will be filled with sample water directly from pump tubing (or by pouring from the bailer). The sample bottles and preservation techniques used will be as described in the QAPP. For the filtered samples, groundwater will be pumped through a 0.45 µm in-line, high-capacity filter. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

Field quality control procedures and quality control sample are described in the QAPP (Section 2).

3.2.3.2 GW-22 Discrete-Depth Alluvial Groundwater Collection

In addition to the groundwater characterization activities described above in Section 3.2.3.1, an attempt will also be made to collect groundwater samples from three distinct screen-depth intervals of well GW-22, as sampled previously at depths of 33, 91, and 188 feet. Data collected one time from these intervals will be used to characterize any distinctions in groundwater quality with depth and will provide information to determine what actions, if any, may be needed to address transport in alluvial groundwater. Collection of groundwater samples from the specific screened intervals in alluvial well GW-22 will first occur without the packer assembly in place. Then, samples will be collected through use of an inflatable packer assembly to isolate specific areas within the well casing. Samples from the screened interval of interest will be collected by low-flow purging and then sampling of the area isolated by the packer assembly.

Two Solinst Model 800 low-pressure inflatable packers will be used in a straddle assembly to isolate the selected interval. The packers will be separated by a section of 1-in diameter 0.020-in slotted well screen and the assembly lowered into place with 2-in diameter PVC drop pipe. The packers will be inflated to operational pressure (35 psi plus 0.43 psi per foot of depth below water) using a bicycle pump, compressed air, or an portable air compressor connected to packer air line. The straddle packer assembly will eliminate vertical flow within the well casing, however since the filter pack is continuous between screen intervals, annular flow may still occur.

When the packers are at the desired depth and inflated to the correct pressure, the interval can be sampled using submersible pump lowered to the bottom of the 2-inch drop pipe (top of the packer system). Purge rate, water level, purge volume and water quality parameters (pH, conductivity, and temperature) will be monitored during sampling. Once the field parameters stabilize (values remain within 10 percent) a sample will be collected. If the turbidity exceeds 10 Nephelometric Turbidity Units (NTU) a filtered sample will be collected along with an unfiltered sample. This process will be repeated until the three screened intervals have been sampled. Samples will be analyzed for parameters typically associate with overburden – dissolved cadmium, manganese, selenium, and sulfate.

3.2.4 Local Domestic Water Supply Wells or Springs

The four local domestic water supply wells or springs that were sampled during the SI (listed on Table 3-1 and shown on Figure 3-4) will be sampled one additional time and analyzed for RI COPCs (Table 3-2), and the data will be used for Site characterization and risk assessment. These local wells or springs are located away from the Smoky Canyon Mine, but within a 5-mile radius of the mine.

3.2.4.1 Sample Collection from Local Domestic Water Supply Wells

Water supply well construction and use information will be compiled from the SI Report and updated, if needed, with any new information. Well information will include whether the well water is used for human and/or animal consumption, as an agricultural source, or for other use, along with typical discharge rates and whether operation is seasonal/periodic or continuous. If the well is in use or is readily available for use, the samples can be collected from the tap (or end of hose). If the well is in continual or regular use, the sample will be collected after running the water for at least one minute; if the well is only used periodically or has been out of service for more than one month, the sample will be collected after allowing the water to run for one well casing volume or 5 minutes of continuous flow if depth of well is unknown.

The water sample should be collected at the source, before any influence of water filtering or other pre-treatment. If a pre-treatment/filter system is in place, such equipment shall be described in the groundwater sample collection notes recorded by the sampler. If the well is not in use, then Simplot shall determine whether sampling is possible considering the condition of the well and whether access can be obtained.

Groundwater samples will be submitted for the analyses listed in Table 3-2. At the same time that samples are collected for laboratory analysis, pH, conductivity, turbidity, dissolved oxygen, redox potential and temperature measurements will be made using field instruments capable of the precision specified for these parameters in the QAPP (Section 2). Field measurements of ferrous iron and total iron (for calculation of ferric iron) will also be performed and recorded at the time of sample collection. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

The details of the groundwater sampling procedure are included in a JRS SOP No. 4, Groundwater Sampling and Water Level Measurements at Monitoring Wells and Piezometers, which is included in the FSP Attachment. A general description of the sampling procedure follows.

Sample bottles will be prepared specifically for the required analyses by the analytical laboratory, and they will be filled with sample water directly from pump tubing (or by pouring from the bailer). The sample bottles and preservation techniques used will be as described in the QAPP. For the filtered samples, groundwater will be pumped through a 0.45 µm in-line, high-capacity filter. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

3.2.4.2 Sample Collection from Local Domestic Water Supply Springs

Water supply spring information will be compiled from the SI Report and updated, if needed, with any new information. Each drinking water spring that is sampled will be described in field notes. Spring information will include an estimate of flow at time of sampling, if possible; surface conditions at the point of discharge; local geology and soil conditions; and local topography including identification of nearby surface drainages. Spring use information will also be recorded based on interviews with users and will include whether the water is used for human and/or animal consumption, as an agricultural source, or for other use, along with typical discharge rates and water production, and whether use is seasonal/periodic or continuous (e.g., periods of low/no flow).

Spring water samples will be collected per the surface water sampling procedures presented in JRS SOP No. 5, Water Quality Sampling (FSP Attachment) and analyzed for the full list of groundwater RI COPCs (Table 3-2). The water sample should be collected at the source, before the influence of any water storage, treatment, or filtering devices. Field notes will specify exactly where and how the sample was collected, including any deviations from the SOP. As described in detail in the SOP, unfiltered samples will be collected directly from the water bodies into sample bottles, or from a bulk surface water sample collected in a one-gallon disposable container and then transferred to sample bottles. If a bulk sample is collected, the container will be rinsed three times with spring water from the location prior to being filled. For the filtered samples, water from the source water body or from the bulk sample will be pumped through a 0.45 µm in-line, high-capacity filter using either a battery-operated peristaltic pump or hand-help manual pump. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters, tubing, and the one-gallon container, if utilized, will be used for only one sample and subsequently disposed.

Temperature, pH, specific conductance, turbidity, ORP, and dissolved oxygen (field parameters) will be measured immediately after sample collection and recorded on field sampling forms. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

3.2.5 Sample Preservation, Handling and Analyses

Groundwater samples collected for laboratory analysis will be preserved as noted in Table 3-3 and handled in accordance with JRS SOP No. 2 (Sample Custody, Packaging and Shipment, FSP Attachment). Each groundwater sample collected as part of the groundwater monitoring task will be submitted for the analyses listed on Table 3-2, and the samples will be analyzed in accordance with the laboratory procedures specified in the QAPP. Some groundwater samples will be analyzed for a subset of the list on Table 3-2 as noted in the discussions above; for example, samples of Wells Formation groundwater collected at wells GW-18, GW-24, and GW-25 under high-flow pumping conditions will be submitted for analyses of parameters typically associated with overburden – dissolved cadmium, manganese, selenium, and sulfate.

3.2.6 Groundwater Sample Designation

Groundwater samples collected in support of the RI will be assigned a unique sample identification number in accordance with procedures identified in the QAPP (Section 2). Each sample identifier will also include general sampling event, location, media type and sample type designations, as follows:

Sampling Event - Location - Media and Type - Number

SC0510-GW18-GW201

The first field in the identification number identifies the general sampling location and time period. For example, samples collected in May 2010 will all have the prefix “SC0510.”

The second field in the identification number identifies the location of the sample. For example, GW-18.

The third field has three parts. The first part is a two- or three-letter acronym that identifies the sample matrix type. Groundwater samples are designated matrix type "GW."

The second part of the third field is comprised of a single digit describing the intended sample use. These sample use codes and include:

0: primary sample

2: field duplicate sample

3: equipment rinsate or QA/QC blank sample

Note that additional codes may be added as the project proceeds. The additions will be communicated immediately to the field staff and data management team.

The third and final part of the third field is a two-digit number unique to the specific sample. Numbers will begin with 01 and increase consecutively as sampling tasks are implemented.

For example, SC0510-GW18-GW201 is a duplicate groundwater sample collected from location GW-18 in May 2010 with the sequential number 01 (i.e., the first groundwater sample collected at that site during that sampling event).

Samples will be immediately labeled in the field and sample numbers shall be recorded at the time of sampling in field notes and on field data collection forms.

3.3 Surface Water Investigations

The surface water investigations identified by the RI/FS Work Plan (Formation, 2011c) include the following tasks (Table 1-1):

- Surface Water Quality Monitoring for COPCs;
- Surface Water Flow Monitoring;
- Seep Water Quality Monitoring for COPCs;
- Seep Flow Monitoring; and
- Storm Water Detention Basin Water Sampling for COPCs.

Additional surface water data will be used to complete the characterization of groundwater conditions in the Wells Formation aquifer and the alluvial aquifer system at the Site. The following tasks are identified with the groundwater data gaps in Table 1-1:

- Detailed Groundwater Discharge Sampling in Hoopes Spring Complex;
- Groundwater Discharge Sampling (Existing Monitoring Locations) at Hoopes Spring and South Fork Sage Creek Springs;
- Sage Creek/Wells Formation Stream Loss Survey;
- Sage Creek Gain-Loss Survey; and
- Inventory and Sampling of Alluvial Discharges to Surface Water in Sage Valley.

Methods for implementing each of these tasks, including the five remaining groundwater investigation tasks, listed above, are described in this section. Surface water monitoring locations are listed in Tables 3-4 and 3-5, except for Hoopes Spring and South Fork Sage Creek springs locations which are listed in Table 3-1. Surface water monitoring locations are shown on Figures 3-5 through 3-9. The complete list of RI COPCs for surface water is presented on Table 3-6.

3.3.1 Objectives

The objectives of the RI surface water investigations are to ensure that sufficient data are available to adequately assess the nature, extent, fate, and transport of all RI COPCs in the surface water system at the Smoky Canyon Mine. The data so developed will be used for Site characterization and risk assessment. Many of the surface water data needs for the RI have been, or are being, filled through implementation of the RI and the ongoing (i.e., spring and fall) surface water monitoring required for Smoky Canyon Mine operations. However, certain data collection activities are required to provide data for risk assessment and to fulfill the Site characterization objectives, as follows:

- Seasonal high-flow and low-flow sampling of surface water at the monitoring stations established during the SI, including new locations established since the SI, with analyses for the complete list of RI COPCs (refer to Table 3-6). The stream sampling locations are shown on Figure 3-5, and include the new Crow Creek monitoring location at the Wyoming state line (CC-WY-01);
- Seasonal high-flow and low-flow discharge measurements in conjunction with the aforementioned stream sampling;
- Quarterly sampling of four ODA seeps (AS-2, DS-7, ES-3, and ES-4; Figure 3-5);
- Sampling of water, if observed, in the drainage swale downgradient from DP-7;
- Continuous seep flow measurements at ODA seeps (DS-7 and ES-3); note that flow measurement at ES-4 was previously planned although it is continuously dry so flow measurement is not possible; monitor flow at ES-3 instead; and
- Sampling of storm-water detention basins in Panels A through E (Figure 3-6), as well as any remaining storm-water detention basins in the Pole Canyon area, and analyses of these samples for the list of RI COPCs (refer to Table 3-6).

In addition, the following surface water investigations will be conducted to support groundwater characterizations:

- One-time detailed flow measurements in Sage Creek to assess stream loss to the Wells Formation aquifer, starting at the western edge of the Wells Formation outcrop area and continuing east of the West Sage Valley Branch fault (surface trace, as mapped) – also, collection of surface water at each flow measurement location for analysis of selenium;
- Collection of gain/loss and aqueous selenium concentration information for the portion of Sage Creek between stations NSV-6 and LSV-2C to identify any reach(es) where Sage Creek gains flow and loading from alluvial groundwater discharge during low-flow conditions;
- Collection and analyses of Wells Formation groundwater discharge to surface water at previously sampled locations at Hoopes Spring and South Fork Sage Creek springs for the complete list of RI COPCs (Table 3-6);
- Collection of discrete groundwater/spring water samples at various locations within the Hoopes Spring Complex area with analysis of these samples for selenium and other overburden indicator parameters, along with major ions; and
- Survey, sampling, and analyses of alluvial groundwater discharge to surface water in upper Sage Valley (north of Sage Creek) and lower Sage Valley (between Sage Creek and South Fork Sage Creek) for the full RI COPC list (Table 3-6).

3.3.2 Surface Water Flow and Water Quality Monitoring

Surface water flow and water quality monitoring will be conducted at the stream stations listed on Table 3-4 and shown on Figure 3-5. Water quality monitoring will also be conducted at ODA seeps AS-2, DS-7, ES-3, and ES-4 as well as at any storm-water detention basins that contain water in the Panels A through E area (Figure 3-6). There are an estimated 51 such detention basins at the mine, though many of these basins detain water for only short periods in response to storm events. These detention basins are listed on Table 3-5, and their locations are shown on Figure 3-6. In addition, continuous flow measurements will be made at ODA seeps DS-7 and ES-3 (ES-4 is dry, so flow measurement is not possible at this location).

3.3.2.1 Locations and Frequency

<u>Stream Monitoring</u>

Surface water quality monitoring (including flow measurements) will be conducted twice per year (in spring and fall) at all stream locations indicated in Table 3-4 and shown on Figure 3-5. These monitoring efforts will coincide with the twice-per-year groundwater monitoring activities, to the extent practicable. Sample collection will be conducted for most monitoring locations on two occasions in 2010, once at low-flow and once at high-flow conditions. An additional two sampling events, once at low-flow and once at high-flow conditions, will be conducted in 2011 at monitoring locations LSV-4, CC-350, and CC-1A in conjunction with sampling during high-flow and low-flow conditions at the new Crow Creek monitoring location at the Wyoming state line (CC-WY-01).

<u>Water Sampling at Hoopes Spring and South Fork Sage Creek Springs</u>

Existing sampling locations at Hoopes Spring and South Fork Sage Creek springs, identified and sampled prior to the RI, are listed on Table 3-1 and shown on Figure 3-7. These locations will be sampled two times, once in the spring and again in the fall, and will be analyzed for the full list of RI COPCs (Table 3-6). The locations include:

- Four Hoopes Spring discharge locations (HS, HS-A1, HS-A2, HS-C1);
- Five South Fork Sage Creek springs discharge locations (LSS-SP-N1, N2, and N [formerly N3 and N4], and LSS-SP-S-1 and S-2); and
- Two South Fork Sage Creek stream locations in the reach of spring discharges – at the upstream end (LSS-SP0) and at the downstream end (LSS).

The two South Fork Sage Creek stream locations will be measured for flow when the water quality samples are collected.

<u>Seep Water Monitoring</u>

Samples will be collected on a quarterly basis, for one year, at the four ODA seep locations shown on Figure 3-5, along with sampling of any water observed in the drainage swale downgradient from the detention basin, DP-7, located below seep DS-7 (along with sediment sampling if surface water is observed – see Section 3.4.3.1). As previously discussed, two of the seeps (DS-7 and ES-3) will be subject to continuous flow measurements. These flow measurements will be made for at least a 6- to 9-month period that includes the spring snowmelt season (March through June). Additional sample collection at seeps DS-7 and ES-3 will be conducted three times in 2011 (spring, summer, fall); seeps AS-2 and ES-4 are continuously dry so it is not possible to collect samples at these locations. Samples will also be collected at monitoring location LP-1 (seep at toe of the Pole Canyon ODA) at the same frequency in 2011 as seeps DS-7 and ES-3.

<u>Stormwater Detention Basin Monitoring</u>

All stormwater detention basins will be visited once during late spring or summer. Samples will be collected from any basin that contains water. The basin locations are listed in Table 3-5 and shown on Figure 3-6.

3.3.2.2 Sampling Equipment and Procedures

Whenever a water quality sample is collected, site location and conditions, current and previous weather conditions, field personnel, and the sampling time and date will be recorded in a project field book along with any other pertinent observations.

The surface water sampling procedures are presented in JRS SOP No. 5, Water Quality Sampling (FSP Attachment). As described in detail in the SOP, unfiltered samples will be collected directly from the water bodies, or from a bulk surface water sample collected in a one-gallon disposable container and then transferred to sample bottles. If a bulk sample is collected, the container will be rinsed three times with water from the location prior to being filled. For the filtered samples, water from the source water body or from the bulk sample will be pumped through a 0.45 µm in-line, high-capacity filter using either a battery-operated peristaltic pump or hand-held manual pump. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

Temperature, pH, specific conductance, turbidity, ORP, and dissolved oxygen (field parameters) will be measured, in-stream, immediately after sample collection and recorded on field sampling forms. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

3.3.2.3 Surface Water Sample Preservation, Handling, and Analyses

Surface water samples collected for laboratory analysis will be preserved as noted in Table 3-3 and handled in accordance with SOP No. 2, Sample Custody, Packaging, and Shipping (FSP Attachment). Each surface water sample collected as part of the surface water monitoring task will be submitted for the analyses listed on Table 3-6, and the samples will be analyzed in accordance with the laboratory procedures specified in the QAPP.

3.3.2.4 Stream Discharge Measurements

Discharge measurements will be made at each of the surface water monitoring locations indicated in Table 3-4 on two occasions, once at low-flow and once at high-flow conditions. The flow measurements will be obtained at each of these locations during similarly scheduled surface water sampling events, and the flow will be measured after the respective sample has been collected at each sampling location.

Where measurements can be made, the measurements will be performed in accordance with JRS SOP No. 6, Surface Water Discharge Measurement (FSP Attachment), and using procedures consistent with those described in the *National Handbook of Recommended Methods for Water Data Acquisition* (USGS, 1977). Flow measurements will be made using one or more of three methods as dictated by streamflow or channel characteristics. Depending on the stream channel characteristics and streamflow rate, an area-velocity method, a portable flume, a volumetric method, or some combination of these methods, will be used to obtain the stream discharge measurements. The method ultimately used will be documented in field records.

In cases where flows are too small or stream gradients are too great to be gauged using the area-velocity method or a cut-throat flume, measurements will be made volumetrically using a calibrated collection container and a stopwatch. Stream flow will be routed through a PVC pipe and the time to fill a collection container to a known volume will be measured. A minimum of five trials will be executed for each volumetric measurement, and discharge will be taken as an average of the five trials. As with flume measurements, an estimate of any leakage around the routing pipe will be recorded.

At locations where the channel substrate or morphology makes quantitative flow measurement impractical, an estimate of flow will be recorded instead. Estimates will be noted as such in field records.

3.3.2.5 Continuous Flow Monitoring at Seeps

Two seeps have been identified for installation of continuous flow monitoring equipment. Seep flows at DS-7 and ES-3 will be directed to temporary flumes, as described in JRS SOP No. 6 (FSP Attachment). Pressure transducers and data loggers will be installed at each temporary flume to record water depths passing through the flumes, which can then be used to compute instantaneous flow rates. The pressure transducer/data logger combination will likely be an In-Situ Level TROLL 500 (vented) with a pressure range of 0-5 pounds per square inch (psi). These units have a reported accuracy of ±0.01 ft and a typical battery life of 5 years or 2 million readings and are in use in other areas of the Site (e.g., Pole Canyon Creek diversion pipeline inlet and outlet structures). The data loggers will be downloaded at least quarterly.

3.3.3 Gain-Loss Surveys

Gain-loss surveys will be conducted to delineate gaining and losing reaches along two stream segments and to assist in identifying areas of groundwater and surface water interactions. Stream gain/loss measurements will be made once during relatively low-flow conditions. These measurements will be made during a period of stable weather such that the flow measurements will not be affected by rainfall/runoff, which could affect the accuracy of the gain/loss assessments.

3.3.3.1 Locations and Frequency

Figure 3-8 identifies specific stream segments that will be evaluated for gaining/losing conditions under the SI. These stream segments are: (1) Sage Creek, starting at the western edge of the Wells Formation outcrop area and continuing east to the mapped surface trace of the West Sage Valley Branch fault; and (2) Sage Creek between monitoring stations NSV-6 and

LSV-2C. Gain-loss surveys to evaluate groundwater interactions are typically most implementable and informative when conducted during low-flow conditions. Therefore, each of these surveys will be conducted once during low-flow conditions.

The gain-loss surveys will be conducted at discrete intervals over the stream reaches of interest, as described for each stream segment below.

1. Sage Creek upstream of Sage Valley

   Stream discharge will be measured along the main Sage Creek channel starting west of the Wells Formation outcrop area, at station US, and ending at a location east of the West Sage Valley Branch Fault trace to identify gain or loss of streamflow across the Wells Formation bedrock. Discharge will be measured at approximate 500-foot intervals to characterize changes in flow along the Sage Creek reach that traverses the Wells Formation outcrop area.

2. Upper /North Sage Valley

   Stream discharge will be measured along the northern fork of Sage Creek and the mainstem of Sage Creek to identify gain or loss of streamflow via interaction with the alluvial aquifer and surface water features. Measurements will start at a location 1,000 feet upstream of monitoring station NSV-6 and continue downstream to station LSV-2C. Discharge will be measured at approximately 1,000-foot intervals to characterize changes in flow. The locations for discharge measurement should include two other established monitoring stations on that reach: NSV-6 and LSV-1 to provide data comparable to past flow measurements obtained in northern Sage Valley.

Flow and field parameters will be measured at each of the locations (i.e., intervals) where flowing water is present during the fall gain-loss survey; reaches with a lack of flow will be noted. The flow measurements will be made synoptically, if possible, starting at the upstream end of the survey reach and continuing downstream to the end of the survey reach. The time of each flow measurement and the weather conditions at the time of flow measurement will be recorded in field notes at each of the survey locations. If possible, the gain-loss survey on each of the two designated stream segments will be completed within a single day.

For the gain-loss surveys conducted on both stream reaches, creek water samples will be collected for laboratory analysis at each flow measurement location. These samples will be analyzed for total and dissolved selenium (in accordance with methods listed in Table 3-6).

3.3.3.2 Stream Discharge Measurements

The measurements will be performed in accordance with JRS SOP No. 6, Surface Water Discharge Measurement (FSP Attachment), and using procedures consistent with those described in the *National Handbook of Recommended Methods for Water Data Acquisition* (USGS, 1977). Flow measurements will be made using one or more of three methods as dictated by streamflow or channel characteristics. Depending on the stream channel characteristics and streamflow rate, an area-velocity method, a portable flume, a volumetric method, or some combination of these methods, will be used to obtain the stream discharge measurements. The method ultimately used will be documented in field records.

In cases where flows are too small or stream gradients are too great to be gauged using the area-velocity method or a cut-throat flume, measurements will be made volumetrically using a calibrated collection container and a stopwatch. Stream flow will be routed through a PVC pipe and the time to fill a collection container to a known volume will be measured. A minimum of five trials will be executed for each volumetric measurement, and discharge will be taken as an average of the five trials. As with flume measurements, an estimate of any leakage around the routing pipe will be recorded.

At locations where the channel substrate or morphology makes quantitative flow measurement impractical, an estimate of flow will be recorded instead. Estimates will be noted as such in field records.

3.3.3.3 Sampling Equipment and Procedures

Surface water samples will be collected during the gain-loss surveys conducted on North Fork Sage Creek to LSV-2C, and in Sage Creek in the Wells Formation outcrop area. Samples will be collected at each flow measurement location. The samples will be analyzed for total and dissolved selenium.

The surface water samples will be collected directly into sample containers, into a pre-rinsed one-gallon disposable container and transferred to sample bottles, or into the containers from a field filtration unit, as appropriate for the parameters to be measured. The laboratory shall prepare and provide sample containers with appropriate preservatives, as specified by the QAPP.

3.3.3.4 Sample Preservation, Handling, and Analyses

Surface water samples collected for laboratory analysis will be preserved as noted in Table 3-3 and handled in accordance with JRS SOP No. 2, Sample Custody, Packaging and Shipping (FSP Attachment).

Each surface water sample collected as part of the gain-loss surveys will be submitted for analyses of total and dissolved selenium in accordance with the laboratory procedures specified in the QAPP.

3.3.4 Detailed Water Sampling at Discrete Locations in Hoopes Spring Complex Area

A separate sampling effort will be conducted one time in the Hoopes Spring Complex area to obtain multiple one-time samples of the water discharging from the Wells Formation aquifer at this location. The samples will be collected at locations of discrete discharge observed within the spring complex, but not previously established as sampling locations. These discrete locations are anticipated to be most readily identifiable along the slope that borders the west side of the spring complex. Even so, the entire spring discharge area will be visually surveyed during this sampling effort in order to identify discrete discharge locations. The samples ultimately collected through this effort (estimated 5 to 20 samples) will be analyzed for parameters typically associated with overburden – dissolved cadmium, manganese, selenium, and sulfate. Samples also will be analyzed for major ions (calcium, magnesium, potassium, sodium, chloride, and nitrate).

Those locations that appear to be distinct discharges of Wells Formation groundwater will be marked in the field, mapped using the coordinates obtained via GPS, and then sampled. If possible, flow measurements will also be made at the discrete spring discharges, coincident with the sampling event.

3.3.4.1 Sampling Equipment and Procedures

Whenever a water quality sample is collected, site location and conditions, current and previous weather conditions, field personnel, and the sampling time and date will be recorded in a project field book along with any other pertinent observations.

The surface water sampling procedures are presented in JRS SOP No. 5, Water Quality Sampling (FSP Attachment). As described in detail in the SOP, unfiltered samples will be collected directly from the water bodies into sample bottles, or first into a pre-rinsed one-gallon disposable container and then transferred to sample bottles. For the filtered samples, water from the source water body or from the bulk sample will be pumped through a 0.45 µm in-line, high-capacity filter using either a battery-operated peristaltic pump or hand-help manual pump. The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

Temperature, pH, specific conductance, turbidity, ORP, and dissolved oxygen (field parameters) will be measured immediately after sample collection and recorded on field sampling forms. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

3.3.4.2 Sample Preservation, Handling, and Analyses

Surface water samples collected for laboratory analysis will be preserved as noted in Table 3-3 and handled in accordance with SOP No. 2, Sample Custody, Packaging and Shipping (FSP Attachment). Each surface water sample collected as part of this detailed Hoopes Spring Complex monitoring task will be submitted for analyses of parameters typically associated with overburden – dissolved cadmium, manganese, selenium, and sulfate. Each sample also will be analyzed for major ions (calcium, magnesium, potassium, sodium, chloride, and nitrate). The samples will be analyzed using the methods specified for these parameters and major ions in Table 3-6.

3.3.5 Alluvial Discharges to Surface Water in Sage Valley

A visual reconnaissance survey will be conducted to identify locations where alluvial groundwater may discharge to Sage Valley. Such locations would not include irrigation-water flows or areas of standing water from recent rainfall events. Six such locations were identified and sampled during the SI in upper Sage Valley north of Sage Creek (Figure 3-9); this includes three “spring areas” and three areas of standing water (i.e., “ponds”). These locations, and any new locations of significant alluvial groundwater discharge identified during the survey, will be sampled as part of the RI and analyzed for the full list of RI COPCs (Table 3-6). In addition, a visual survey will also be conducted in lower Sage Valley (between Sage Creek and South Fork Sage Creek). Any locations where it appears that significant alluvial groundwater discharges to the surface will be recorded and sampled. These water samples will be analyzed for the full list of RI COPCs (Table 3-6).

The surveying and sampling of potential alluvial discharges will be conducted during late spring or summer conditions. Those locations that appear to be distinct discharges of alluvial groundwater will be marked in the field, mapped using the coordinates obtained via GPS, and then sampled. The field description will include an estimate of flow, if possible, the area where seepage occurs, surface conditions at the point of discharge, local geology and soil conditions, local topography, and proximity to ODAs and surface drainages.

3.3.5.1 Sampling Equipment and Procedures

Whenever a water quality sample is collected, site location and conditions, current and previous weather conditions, field personnel, and the sampling time and date will be recorded in a project field book along with any other pertinent observations.

The surface water sampling procedures are presented in JRS SOP No. 5, Water Quality Sampling (FSP Attachment). As described in detail in the SOP, unfiltered samples will be collected directly from the water bodies into sample bottles, or first into a pre-rinsed one-gallon disposable container, and then transferred to sample bottles. For the filtered samples, water from the source water body or from the bulk sample will be pumped through a 0.45 µm in-line, high-capacity filter using either a battery-operated peristaltic pump or hand-help manual pump.

The in-line filter will be purged with approximately 200 mL of sample water before the laboratory container is filled. Filters and tubing will be used for only one sample and subsequently disposed.

Temperature, pH, specific conductance, turbidity, ORP, and dissolved oxygen (field parameters) will be measured immediately after sample collection and recorded on field sampling forms. Field parameter measurement and calibration protocols are detailed in JRS SOP No. 5 (Water Quality Sampling), MFG SOP No. 17 (Field Measurement of Dissolved Oxygen), and MFG SOP No. 13 (Field Measurement of Oxidation-Reduction Potential) (FSP Attachment).

3.3.5.2 Sample Preservation, Handling, and Analyses

Surface water samples collected for laboratory analysis will be preserved as noted in Table 3-3 and handled in accordance with SOP No. 2, Sample Custody, Packaging and Shipping (FSP Attachment). Each surface water sample collected as part of this monitoring task will be submitted for the analyses listed on Table 3-6, and the samples will be analyzed in accordance with the laboratory procedures specified in the QAPP.

3.3.6 Surface Water Sample Designation

Surface water samples collected in support of the RI will be assigned a unique sample number in accordance with procedures identified in the QAPP (Section 2). Each sample identifier will also include general sampling event, location, media type and sample type designations, as follows:

Sampling Event - Location - Media and Type – Number

SC0510-LSS-SW001

The first field in the identification number identifies the general sampling location and time period. For example, samples collected in May 2010 will all have the prefix “SC0510.”

The second field in the identification number identifies the location of the sample. For example, the location LSS.

The third field has three parts. The first part is a two- or three-letter acronym that identifies the sample matrix type. Surface water samples are designated matrix type “SW.”

The second part of the third field is comprised of a single digit describing the intended sample use. These sample use codes and include:

0: primary sample

2: field duplicate sample

3: equipment rinsate or QA/QC blank sample

Note that additional codes may be added as the project proceeds. The additions will be communicated immediately to the field staff and data management team.

The third and final part of the third field is a two-digit number unique to the specific sample. Numbers will begin with 01 and increase consecutively as sampling tasks are implemented.

For example, SC0510-LSS-SW001 is a primary surface water sample collected from location LSS in May 2010 with the sequential number 01 (i.e., the first surface water sample collected at that site during that sampling event).

Samples will be immediately labeled in the field and sample numbers shall be recorded at the time of sampling in field notes and on field data collection forms.

3.4 Field Sampling Plan References

Formation Environmental, 2011a. Monitoring Well GW-CO-2 Installation Plan, Smoky Canyon Mine. Prepared for Simplot and submitted to IDEQ, March 3.

Formation Environmental, 2011b. Draft Corrective Action Completion Report for the Culinary Well and Corrective Action Plan for the Industrial Well, prepared for Simplot Smoky Canyon Mine and submitted to IDEQ, February 28.

Formation Environmental, LLC. 2011c. Final Smoky Canyon Mine RI/FS Work Plan (Rev03). Prepared for J.R. Simplot Company, May.

United States Geological Survey. 1977. National Handbook of Recommended Methods for Water-Data Acquisition. U.S. Department of the Interior, Office of Water Data Coordination, U.S. Geological Survey, Reston, VA.

FIELD SAMPLING PLAN
TABLES 3-1, 3-2, 3-4, 3-6

Table 3-1 (SAP Addendum 01, May 2011)

Smoky Canyon Mine Groundwater Monitoring Wells, Water Supply Wells/Springs, and Hoopes and South Fork Sage Creek Springs Monitoring Locations

Location ID	Location Description	Year Well Installed	Surface Elevation	MP Elevation	Total Depth	Screened Interval	Water Level Monitoring		Sampling Timing or Frequency	
			(ft amsl)	(ft amsl)	ft (bgs)	ft (bgs)	Quarterly	Continuous	Spring, Fall	1 round
Wells Formation Monitoring and Water Supply Wells										
GW-CO	Panels B and C Consent Order monitoring well	2003	7229.8	7231.3	660	598.5-649.5	---	x	---	x
GW-CO-2	New well northeast of Industrial Well, under Panels B and C Consent Order	2011	tbd [a]	tbd	tbd	tbd	---	x [b]	x [c]	
Industrial Well	Industrial Well - mill/drinking water supply (well is pumped, no levels possible with pump configuration)	1983	7225	7226	1319	639-1319	---	---	x [c]	
GW-16	Downgradient of Pole ODA	2003	6852.9	6854.4	280	230-280	---	x	---	x
GW-18	Upgradient of Hoopes Spring	2003	6674.1	6675.6	105	55-105	---	x	---	x
GW-24	East of D Panel	2007	6784.5	6787	225	174.7-204.7	---	x	---	x
GW-25	East of E Panel	2007	6704	6706.82	125	70-120	---	x	---	x
GW-27	West of Boulder Creek Anticline, between Panels D and E	2010	6867.5	6870.94	300	274 5-295	---	x	x	---
MC-MW-1	South of E Panel on South Fork Sage Creek	2003	6777.1	6780.1	210	159.9-209.9	---	x	---	x
MW-F-1	Indicator well, east of Panel F	2009	7328.3	7329.8	786	735-780	---	x	---	x
MW-F-2	Indicator well, east of Panel F	2009	7711	7713.5	1125	1103-1113	---	x	---	x
MW-F-1A	Downgradient well between Panel F and South Fork Sage Ck	2009	6928.4	6930.66	354.6	297-347	---	x	---	x
Shallow Alluvial Monitoring Wells										
GW-15	Downgradient of Pole ODA	2003	6851.6	6854.2	45	15-45	---	x	---	x
GW-17	Upgradient of Hoopes Spring	2003	6674.6	6677.4	35	5-35	x	---	x	---
GW-19b	Lower Sage Valley east	2003	6637.7	6640.1	52	12-52	x	---	x	---
GW-20	Lower Sage Valley near confluence of Sage Ck and South Fork Sage Creek	2003	6537	6539.9	69	19-69	x	---	x	---
GW-21	On South Fork Sage Creek above springs	2003	6693	6696.4	24.5	4.5-24.5	x	---	x	---
GW-22	Located just southeast of Pole Canyon on the western edge of Sage Valley	2003	6758.1	6760	220	23-218	---	x	---	x [d]
GW-26	Downgradient of Pole ODA, upgradient of pipeline discharge	2008	6882.7	6885.39	30	10-30	---	x	x	---
Local Domestic Water Supply Wells or Springs										
BSS-1	Boy Scout Spring #1: located east of Diamond Creek campground near the road leading to Smoky Canyon Mine	---	---	---	---	---	---	---	---	x
DW-2	Hartman Ranch Spring located just north of Hartman Ranch along Crow Creek Road	---	---	---	---	---	---	---	---	x
DW-3	Lagomarsino domestic well at the Key Largo Ranch along Crow Creek Road	---	---	---	---	---	---	---	---	x
DW-4	Peterson Sage Valley homestead ranch spring	---	---	---	---	---	---	---	---	x
Monitoring Locations for Springs Discharging Groundwater from Wells Formation		Yr Established								
HS	Hoopes Spring at old flume	1990	---	---	---	---	---	---	x	---
HS-A1	Hoopes Spring north/east of station HS	2006	---	---	---	---	---	---	x	---
HS-A2	Hoopes Spring east of stations HS and HS-A1	2006	---	---	---	---	---	---	x	---
HS-C1	Hoopes Spring south of station HS	2006	---	---	---	---	---	---	x	---
LSS-SP-N1	South Fork Sage Ck springs, north side 1	2007	---	---	---	---	---	---	x	---
LSS-SP-N2	South Fork Sage Ck springs, north side 2	2007	---	---	---	---	---	---	x	---
LSS-SP-N	South Fork Sage Ck springs, includes former locations north side 3 and 4	2007	---	---	---	---	---	---	x	---
LSS-SP-S-1	South Fork Sage Ck springs, south side 1	2007	---	---	---	---	---	---	x	---
LSS-SP-S-2	South Fork Sage Ck springs, south side 2	2007	---	---	---	---	---	---	x	---
LSS-SP0 [e]	South Fork Sage Ck, upstream of spring discharge area (surface water location)	2007	---	---	---	---	---	---	x	---
LSS [e]	South Fork Sage Ck, downstream of spring discharge area (surface water location)	1979	---	---	---	---	---	---	x	---

[a] tbd = to be determined (upon installation of well)

[b] Daily water level measurements, as possible, at new well GW-CO-2 during well installation process; continuous transducer measurements thereafter.

[c] Water quality to be monitored, as possible, at new well GW-CO-2 during well installation process; also, monthly water quality sampling at Industrial Well, GW-CO, and GW-CO-2 for first 3-6 months after GW-CO-2 completed.

[d] Additional depth-discrete sampling (3 distinct depths) at GW-22.

[e] Surface water (stream) location sampled for water quality and measured for flow rate.

Table 3-2 (SAP Addendum 01, May 2011)
Groundwater [1] Monitoring Parameters

Parameter	Analytical Method	Reporting Limit (mg/L)
Field Measurements		
Depth to Water	Water Level Indicator	---
Temperature	digital thermometer	---
pH	field electrode/pH meter	---
Specific conductance	field conductivity meter	---
Turbidity	field turbidity meter	---
Dissolved oxygen	field DO meter	1 mg/L
Oxidation-reduction potential	field ORP meter	1 mg/L
Ferrous Iron	field spectrophotometer	0.3 mg/L
Total Iron (for calculation of ferric iron)	field spectrophotometer	0.3 mg/L
Metals[2]		
Aluminum	6010B	0.1
Antimony	6020	0.003
Arsenic	6020	0.003
Barium	6020	0.001
Beryllium	6020	0.0002
Boron	6010B	0.05
Cadmium	6020	0.0002
Chromium	6020	0.0015
Cobalt	6020	0.001
Copper	6020	0.001
Iron	6010B	0.06
Lead	6020	0.003
Manganese	6020	0.001
Mercury	7470A	0.0002
Molybdenum	6020	0.001
Nickel	6020	0.001
Selenium	6020/SM 3114C	0.003 / 0.002
Silver	6020	0.0001
Thallium	6020	0.001
Uranium	6020	0.001
Vanadium	6020	0.0015
Zinc	6020	0.005
Major Cations		
Calcium, dissolved	6010B	0.05
Magnesium, dissolved	6010B	0.10
Potassium, dissolved	6010B	0.5
Sodium, dissolved	6010B	0.5
Anions		
Chloride	300.0	0.2
Nitrate/Nitrite, as N	353.2	0.5
Sulfate	300.0	1.0
Other		
Alkalinity[3]	SM 2320B	1
Total Organic Carbon (TOC)	SM 5310B	1
Total Dissolved Solids (TDS)	SM 2540C	10
Total Suspended Solids (TSS)	SM 2540D	5

[1] Samples collected at locations listed on Table 3-1 will be analyzed for these parameters, except for springs discharging from Wells Formation groundwater.

[2] Analyze total and dissolved concentrations.

[3] A kalinity includes bicarbonate, carbonate, and hydroxide concentrations.

Table 3-4 (SAP Addendum 01, May 2011)
Surface Water, Sediment, and Aquatic Biota Monitoring Locations

Monitoring Location	Description	Stream Reach	Location Use			
			Flow Measurement	Water Sampling	Sediment Sampling	Aquatic Biota Sampling
Smoky Creek						
USm	Upper Smoky Creek	Upper Smoky Creek	X	X	X	X
MSm	Middle Smoky Creek	Upper Smoky Creek	X			
LSmS	Lower Smoky Spring	Lower Smoky Creek	X	X		
LSm	Lower Smoky Creek	Lower Smoky Creek	X	X	X	X
Roberts Creek						
UR-3	Upper Roberts Creek below confluence of springs	Roberts Creek	X	X	X	X
Pole Canyon Creek						
UP-PD	Upper Pole Canyon Creek (replaces UP)	Upper Pole Creek	X	X		
LP-1	Lower Pole Canyon Creek where creek emanates from toe of pile	Lower Pole Creek	X	X		
LP-PD	Lower Pole Canyon Creek (replaces LP)	Lower Pole Creek	X	X	X	X
Sage Creek						
US	Upper Sage Creek	Upper Sage Creek	X	X	X	X
US-4	Upper Sage Creek	Upper Sage Creek	X	X	X	X
SV-1	Sage Creek irrigation diversion ditch	Lower Sage Creek	X	X	X	
LS	Lower Sage Creek	Lower Sage Creek	X	X	X	X
Hoopes Spring						
HS	Hoopes Spring	Hoopes Spring	X	X		
HS-2	Hoopes Spring downstream of TRC-HS at old ranch house	Hoopes Spring	X	X		
HS-3	Hoopes Spring Creek at the mouth upstream of Sage Creek	Hoopes Spring	X	X	X	X
South Fork Sage Creek						
USS	Upper South Fork Sage Creek	Upper South Fork Sage Creek	X	X		
LSS-SP-0	South Fork Sage Creek upstream of spring area (replaces LSS-1a)	Lower South Fork Sage Creek	X	X		
LSS	Lower South Fork Sage Creek	Lower South Fork Sage Creek	X	X	X	X
LSS-2	South Fork Sage Creek below mine	Lower South Fork Sage Creek	X	X		
North Fork Sage Creek and North Sage Valley						
NSV-1	Stock pond in northern Sage Valley - under power lines	North Sage Valley		X		
NSV-2	North Sage Valley Spring; Petersons Spring - fenced pond fed by spring	North Sage Valley	X	X		
NSV-3	North Sage Valley Creek; North Sage Creek near Petersons	North Sage Valley	X	X		
NSV-4	North Sage Valley Creek; Flow from Petersons spring to North Sage Creek	North Sage Valley	X	X		
NSV-5	North Sage Creek above most Pole Creek inflow	North Sage Valley	X	X		
NSV-6	North Sage Creek above ranch and below most Pole Creek inflow	North Sage Valley	X	X	X	X
SVP-1	Sage Valley Pond #1: west side of valley south of Pole Canyon Creek	North Sage Valley		X		
SVP-2	Sage Valley Pond #2: located in northeastern portion of Sage Valley	North Sage Valley		X		
SVP-3	Numerous ponds in area just west of Peterson Ranch house in Sage Valley	North Sage Valley		X		
SVS-1	Sage Valley Spring Area #1	North Sage Valley	X	X		
SVS-2	Sage Valley Spring Area #2	North Sage Valley	X	X		
SVS-3	Sage Valley Spring #3: located in northern tip of Sage Valley	North Sage Valley	X	X		
Lower Sage Valley						
LSV-1	Lower Sage Creek below North Fork Sage Creek	Lower Sage Valley Upper	X	X	X	
D-1	Irrigation Ditch inflow to Sage Creek upstream of Hoopes Spring inflow	Lower Sage Valley Upper	X	X		
LSV-1a	Lower Sage Valley Sage Creek upstream of Hoopes Spring Creek	Lower Sage Valley Upper	X	X		
LSV-1b	Sage Creek, below North Fork Sage Creek	Lower Sage Valley Middle	X	X		
LSV-2C	Lower Sage Creek below Hoopes Spring (replaces LSV-2; used for aquatic resource monitoring 2006-2009)	Lower Sage Valley Middle	X	X	X	X
LSV-SP1	Lower Sage Valley Spring #1	Lower Sage Valley Middle	X	X		
LSV-2a	Lower Sage Creek upstream of South Fork Sage Creek	Lower Sage Valley Middle	X	X		
LSV-3	Lower Sage Creek below South Fork Sage Creek	Lower Sage Valley Lower	X	X	X	X

LSV-3a	Lower Sage Creek	Lower Sage Valley Lower	X	X		
LSV-4	Lower Sage Creek above bridge for main Crow Creek road	Lower Sage Valley Lower	X	X	X	X
Crow Creek						
CC-350	Crow Creek above Sage Creek (replaces CC-2)	Crow Creek	X	X	X	X
CC-1A	Crow Creek below Sage Creek (replaces CC-1)	Crow Creek	X	X	X	X
CC-WY-01	Crow Creek at Wyoming State Line	Crow Creek	X	X		
Tygee Creek						
UT-1	Upper Tygee Creek	Upper Tygee Creek	X	X		
ET	East Tygee Creek	East Tygee Creek	X	X		
LT-3	Lower Tygee Creek	Tygee Creek	X	X	X (LT-5)	X(LT-5)
Panel A						
AS-2	A Panel External Overburden seep located on the northeastern toe	--	X	X		
Panel D						
DS-7	D Panel seep located along the southeastern toe	--	X	X		
Panel E						
ES-3	North E Panel Panel seep	--	X	X		
ES-4	Central E Panel seep	--	X	X		

Table 3-6 (SAP Addendum 01, May 2011)
Parameters for Analyses of Surface Water

Parameter	Analytical Method	Reporting Limit (mg/L)
Field Measurements		
Discharge	flow meter or installed flume	---
Temperature	digital thermometer	---
pH	field electrode/pH meter	---
Specific conductance	field conductivity meter	---
Turbidity	field turbidity meter	---
Dissolved oxygen	field DO meter	1 mg/L
Oxidation-reduction potential	field ORP meter	1 mg/L
Metals[1]		
Aluminum	6010B	0.1
Antimony	6020	0.003
Arsenic	6020	0.003
Barium	6020	0.001
Beryllium	6020	0.0002
Boron	6010B	0.05
Cadmium	6020	0.0002
Chromium	6020	0.0015
Chromium III/VI[2]	7199	0.005
Cobalt	6020	0.001
Copper	6020	0.001
Iron	6010B	0.06
Lead	6020	0.003
Manganese	6020	0.001
Mercury	7470A	0.0002
Molybdenum	6020	0.001
Nickel	6020	0.001
Selenium	6020/SM 3114C	0.003 / 0.002
Silver	6020	0.0001
Thallium	6020	0.001
Uranium	6020	0.001
Vanadium	6020	0.0015
Zinc	6020	0.005
Major Cations[3]		
Calcium	6010B	0.05
Magnesium	6010B	0.10
Potassium	6010B	0.5
Sodium	6010B	0.5
Anions		
Chloride	300.0	0.2
Nitrate/Nitrite, as N	353.2	0.05
Sulfate	300.0	1.0
Other		
Alkalinity[4]	SM 2320B	1
Hardness	by calculation (Mg, Ca)	0.1
Total Organic Carbon (TOC)	SM 5310B	1
Total Dissolved Solids (TDS)	SM 2540C	10
Total Suspended Solids (TSS)	SM 2540D	5

[1] Analyze total and dissolved concentrations of metals/metalloids.
[2] Cr III by calculation from Cr VI and total Cr concentrations. Analyses for Cr VI will only be performed when a previous result for total chromium was >/= 0.011 mg/L.
[3] Analyze dissolved concentrations of major cations.
[4] A kalinity includes bicarbonate, carbonate, and hydroxide concentrations.

FIELD SAMPLING PLAN
FIGURES 3-3, 3-5, 3-7

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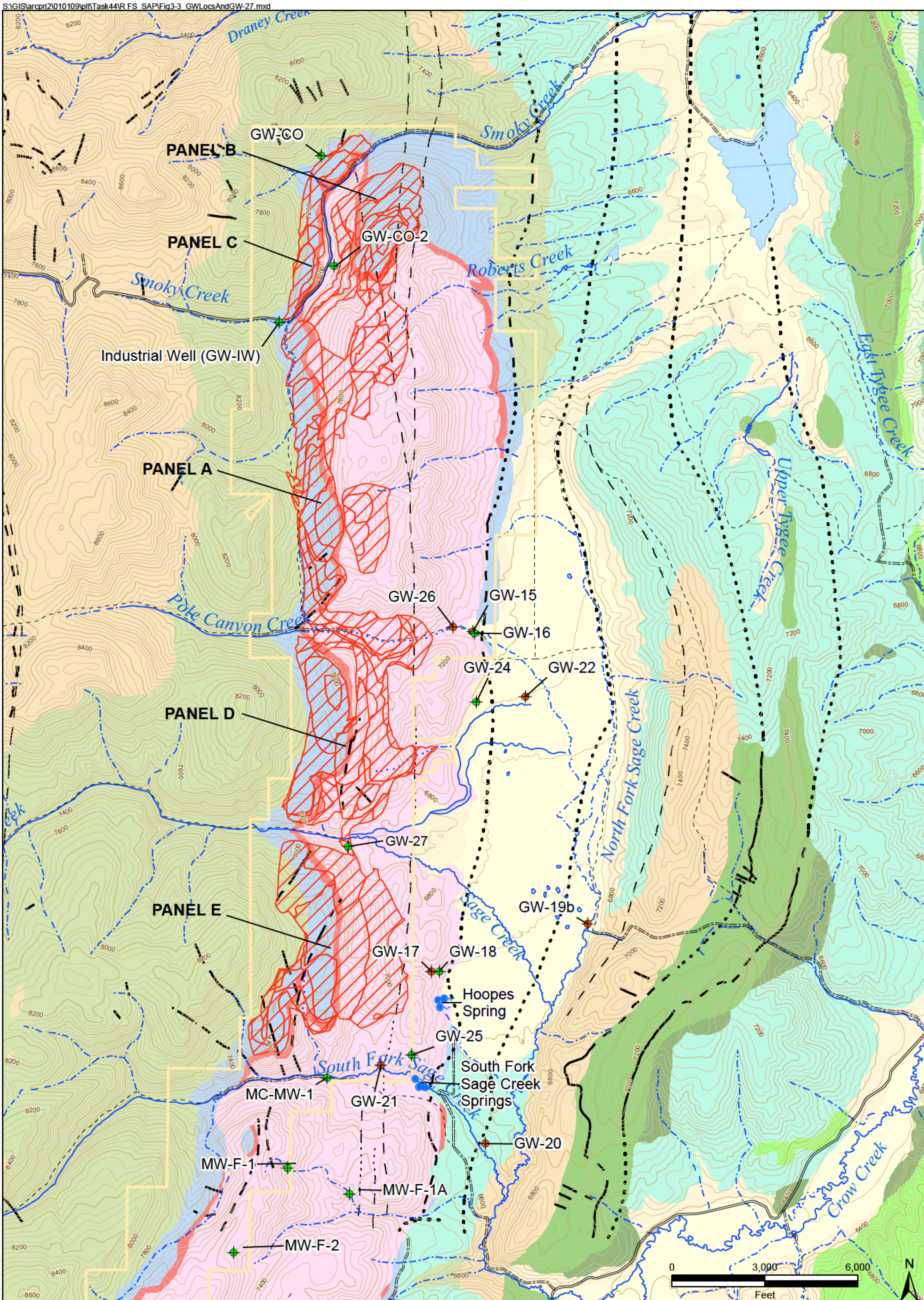

Legend

Groundwater Monitoring Location

- Wells Formation Monitoring or Water Supply Well
- Shallow Alluvial Monitoring Well
- Spring Discharging Groundwater from Wells Formation (see Figure 3-7)
- Lease Area/Active Mineral Extraction Area
- Mine Disturbance Areas (Panels A-E)
- Roads
- Unimproved Roads
- Trail / 4WD
- Perennial Stream
- Intermittent Stream

Surface Geology (Mansfield, 1927)

Qal	*Alluvium*
Qw	*Hill wash and older alluvium*
Tsl	*Salt Lake formation*
Kge	*Ephraim conglomerate*
Js	*Stump sandstone*
Jp	*Preuss sandstone*
Jtc	*Twin Creek limestone*
Jn	*Nuggest sandstone*
TRt	*Thaynes group*
TRw	*Dinwoody shale*
Cpb	*Rex chert*
Cpa	*Meade Peak formation*
Cw	*Wells formation*
Cb	*Brazer limestone*

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FIGURE 3-3

GROUNDWATER MONITORING LOCATIONS

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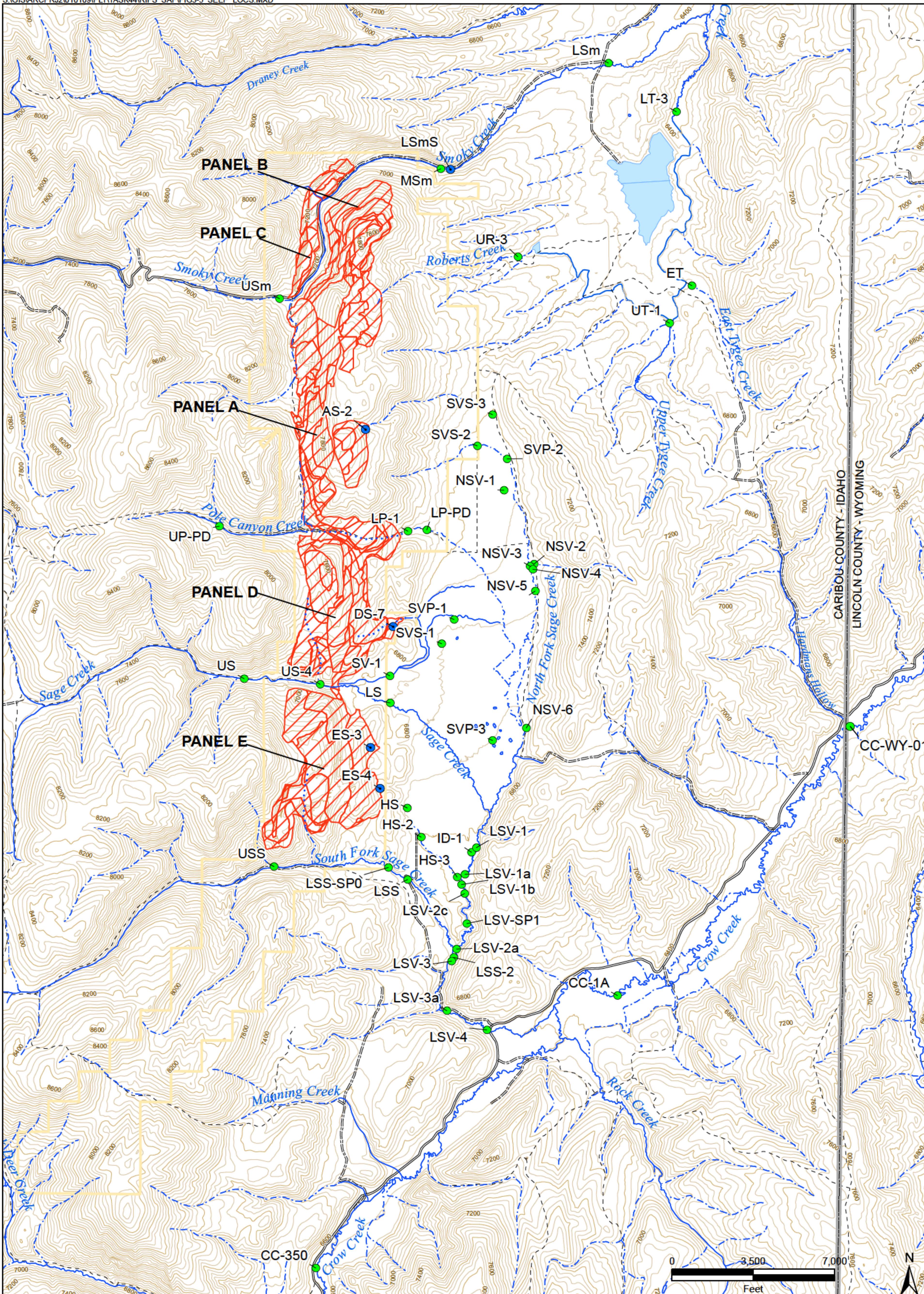

Legend

Surface Water Monitoring Location

- Seep or Spring Monitoring Location
- Stream Monitoring Location
- Lease Area/Active Mineral Extraction Area
- Mine Disturbance Areas (Panels A-E)
- Roads
- Unimproved Roads
- Trail / 4WD
- Perennial Stream
- Intermittent Stream

Notes:
1. Mine disturbance area boundary includes a 50-foot buffer.
2. Topographic surface reflects 2004 conditions in mine disturbance areas.
3. Hoopes Spring and South Fork Sage Creek Springs monitoring locations are shown on Figure 2-7.

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FIGURE 3-5

SURFACE WATER MONITORING LOCATIONS

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Legend

Spring Monitoring Location	Elevation Contour (25-ft interval)
Stream Monitoring Location	Elevation Contour (5-ft interval)

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FIGURE 3-7
WATER QUALITY MONITORING LOCATIONS IN HOOPES SPRING AND SOUTH FORK SAGE CREEK SPRINGS

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